Architecture of decision support systems

As shown in Figure 1, a DSS consists of two major sub-systems – **human decision makers** and **computer systems**.
Interpreting a DSS as only a computer hardware and software system is a common misconception. An unstructured (or semi-structured) decision by definition cannot be programmed because its precise nature and structure are elusive and complex.
The function of a human decision maker as a component of DSS is not to enter data to build a database, but to exercise judgment or intuition throughout the entire decision making process.
Imagine a manager who has to make a five-year production planning decision. The first step of the decision making process begins with the creation of a decision support model, using an integrated DSS program (DSS generator) such as Microsoft Excel, Lotus 1-2-3, Interactive Financial Planning Systems (IFPS)/Personal or Express/PC. The user interface sub-system (or dialogue generation and management systems) is the gateway to both database management systems (**DBMS**) and model-based management systems (**MBMS**). DBMS are a set of computer programs that create and manage the database, as well as control access to the data stored within it.

The **DBMS** can be either an independent program or embedded within a DSS generator to allow users to create a database file that is to be used as an input to the DSS.
MBMS is a set of computer programs embedded within a DSS generator that allows users to create, edit, update, and/or delete a model. Users create models and associated database files to make specific decisions. The created models and databases are stored in the model base and database in the direct access storage devices such as hard disks. From a user's viewpoint, the user interface subsystem is the only part of DSS components with which they have to deal. Therefore, providing an effective user interface must take several important issues into consideration, including choice of input and output devices, screen design, use of colors, data and information presentation format, use of different interface styles, etc.
Today's decision support system generator provide the user with a wide variety of interface modes (styles): menu based interaction mode, command language style, questions and answers, form interaction, natural language processing based dialogue, and graphical user interface (GUI). GUIs use icons, buttons, pull-down menus, bars, and boxes extensively and have become the most widely implemented and versatile type. The interface system allows users access to:

(1) The data sub-system: (a) database (b) database management software; and
(2) The model sub-system:
    (a) Model base
    (b) Model base management software.

(See Fig. 1)

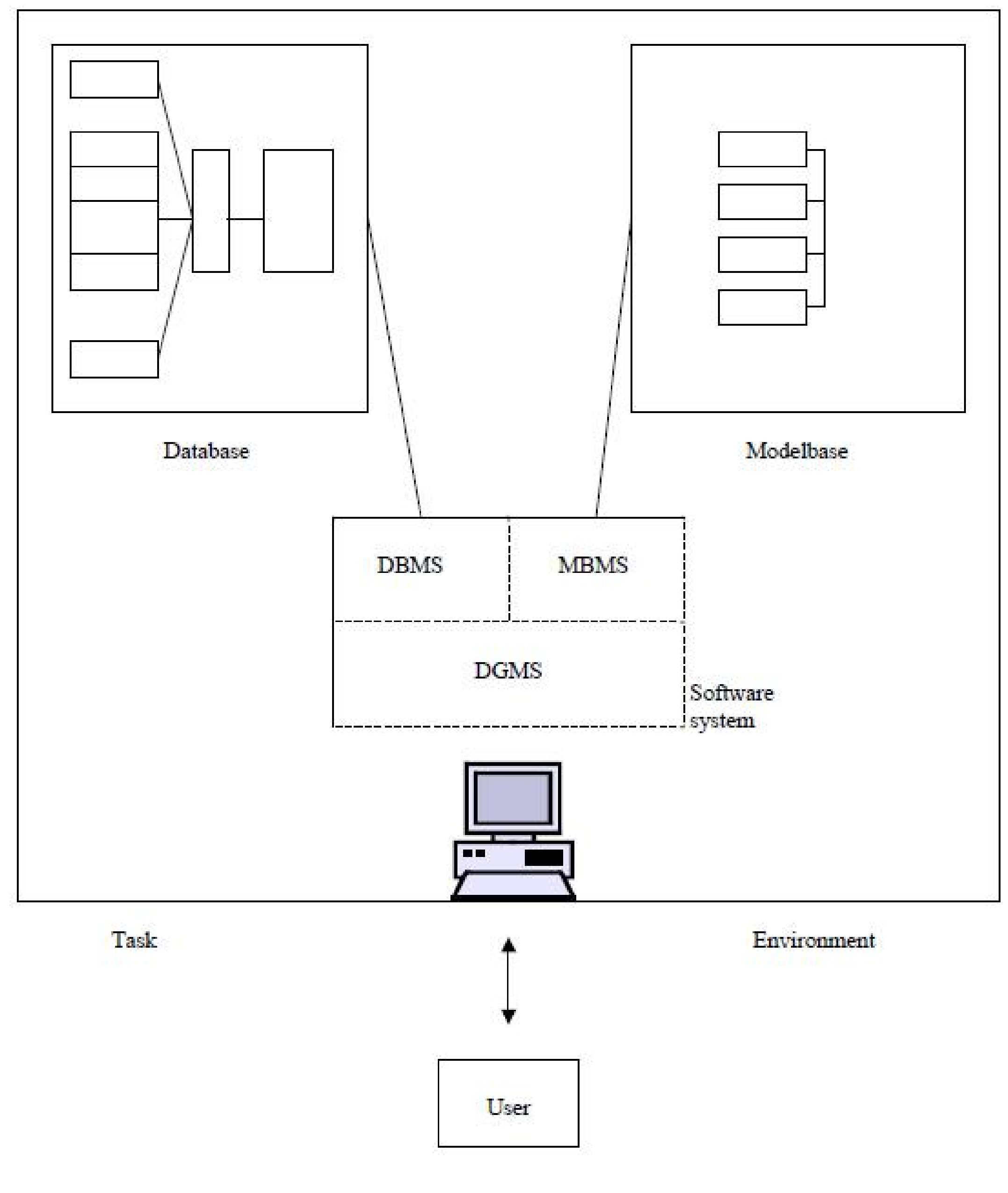


Figure 1 Components of decision support system
Source: Sprague and Carlson (1982: 29)

Data/model management

Since model and data management in DSS are inseparable subjects, many DSS researchers continue to focus on both fields of data and model management.
Data are facts which result from the observation of physical phenomena such as daily production quantity, daily sales quantity and inventory level of product A. A database is a collection of interrelated files. Database management systems are computer programs which are primarily concerned with managing a large amount of data in a physical storage such as hard disks and creating, updating and querying databases in an optimal way.

Data management in DSS is a necessary function primarily useful in the intelligence stage of the decision making process, but not sufficient to support design and choice stages of decision-making processes.
To adequately support these stages, DSS should be able to include the following activities: projection, deduction, analysis, creation of alternatives, comparison of alternatives, optimization, and simulation.

In performing these essential tasks, DSS utilizes many types of management science/operations research **(MS/OR**) models. They include linear programming, integer programming, network models, goal programming, simulation and statistical models and spreadsheet modeling.

All these models are stored in the model base. Model-based management systems are computer programs used as a part of a DSS generator to build models, restructure models and update models. In association with model management, multiple criteria decision making (MCDM) model embedded DSS and knowledge-based DSS have emerged recently as important DSS research sub-specialties.

User interface sub-systems

The functions of the user interface (dialogue generation and management) sub-system are to:

1- Allow the user to create, update, delete database files and decision models via database management systems and model-based management systems;

2- Provide a variety of input and output formats. The formats include multi-dimensional color graphics, tables and multiple windows in a screen;

3- Provide different styles of dialogues (such as graphical user interfaces, menus, direct command languages, form interaction, natural language interaction, and questions and answers).

Research in user interface sub-systems has investigated several important issues in the designing, building, and implementing of a user interface. They include data /information display formats (for example, tabular versus graphics), cognitive and psychological factors, use of multimedia (multiple media combined in one application) and hypermedia (documents that contain several types of media linked by association), 3-dimemensional user interfaces, virtual reality and its impact on decision making, geographical information systems, and natural language processing.

Knowledge-based decision support systems

Another important emerging DSS sub-specialty is the study of knowledge-based decision support systems (KBDSS), which are hybrid systems of DSS and ES that help solve a broad range of organizational problems.
In integrating DSS and ES, two basic approaches are discernible and labeled expert support systems (ESS) and intelligent support systems (ISS. The key differences between these two systems are as follows.

ESS is to replace human expertise with machine expertise, while ISS are to amplify the memory and intelligence of humans and groups. A broad range of real-world managerial problems can be better solved by using the analysis of both quantitative and qualitative data. Few would disagree with the notion that there are considerable benefits from integrating DSS and ES. The new integrated system (ESS or ISS) can support decision makers by harnessing the expertise of key organizational members. A bottleneck in the development of knowledge-based systems such as ESS is knowledge acquisition, which is a part of knowledge engineering – the process includes representation, validation, inferencing, explanation and maintenance.

Decision support system implementation

Use of some computer-based information systems such as TPS and MIS are, in most cases, mandatory. But decision support systems are voluntary systems. In regard to voluntary systems, DSS implementation research has been important for ascertaining the influence of success factors of DSS implementations. DSS implementation researchers are investigating the relationship between user-related factors and implementation success. User factors include cognitive style (the characteristic ways individuals process and utilize information to solve problems), personality (the cognitive structures maintained by individuals to facilitate adjustment to events and situations), demographics (age, sex and education), and user-situation variables (training, experiences and user involvement).

Future implementation research should be directed toward the development of causal models of user-related implementation factors. Furthermore, it is suggested that DSS researchers shift the research focus from user-related factors to the contextual variables. An important assumption on which the DSS implementation research is based is that DSS are voluntary systems. A recent survey of DSS suggests that an increasing number of DSS have become a strategic tool for organizational survival. Thus, these systems are no longer voluntary ones. Future DSS implementation research must take this changing nature of DSS from voluntary systems to mandatory survival tools.

Consequently, individual differences, cognitive styles, personality, demographics, and user-situational variables may become less critical success factors. Shifting the focus of implementation research from user-related factors to task-related, organizational, and external environmental factors may be necessary to reflect the changing decision environment in which organization must survive and prosper.

Decision support system evaluation

Evaluation of DSS is concerned with analyzing costs and benefits of DSS before and after DSS development and implementation. The unique nature of DSS evaluation is that although some DSS provide substantial cost saving and profit increases, measurements of benefits of DSS have been problematic as quantification of the positive impacts of improved decision process is difficult. Therefore, DSS evaluation research deals with the following methodologies: decision outputs, changes in the decision process, changes in managers' concepts of the decision situation, procedural changes, cost/benefit analysis, service measures and managers' assessment of the system's value.

Applications of decision support systems

According to a survey (Eom *et al*. 1998), computer-based DSS are widely applied in both profit making (about 72 per cent) and non-profit organizations (about 28 per cent). In corporate functional management fields, production and operations management contain the largest number of application articles, followed by management information systems, marketing, finance, strategic management and multifunctional areas.
Two functional fields are relatively minor fields for DSS application: international business and accounting/auditing.

Refer to http://cstlhcb.semo.edu/eom/ORINSIHT.HTM for a more detailed classification of 271 DSS articles by application areas).

The World Wide Web and Group/Organizational/Global DSS

The World Wide Web is increasingly being used as the client-server platform of many business organizations due to its network and platform-independence and very low software/installation/maintenance costs. More and more groupware will be inextricably tied to Internet technology. Especially, the World Wide Web is becoming an infrastructure for the next generation of decision support systems and groupware applications. Many groupware products, such as Lotus Development's Domino and Microsoft's Exchange, are integrating more Internet protocols into them.

Microsoft's next version of Office suite is expected to completely remove the boundaries between the World Wide Web and groupware. Many companies are applying groupware technology to increase business-to-business collaborations (e.g. collaborations among the company, its customers, and its suppliers, a.k.a. super-work-group software) over intranets and extranets (see COMPUTER-SUPPORTED COOPERATIVE NETWORK). Another development in the information systems area is the growing importance of enterprise resources planning (ERP) systems. ERP systems are a new generation of information systems packages that integrate information and information-based processes within and across functional areas in an organization. ERP has focused primarily on processing of transaction data resulting in the creation of the extensive, organizational databases of an organization that may consist of individual business units across the globe. The extensive databases created by the ERP system provide the platform for decision support, data warehousing, data mining, and executive support systems.

Integrated solutions provided by the ERP system are attributable to the use of the common database.
As we enter the age of the global village where geographical and temporal boundaries are shrinking rapidly, global DSS are emerging as the new frontiers in management information systems area. Over the next decade, DSS will focus on teams, work groups, and distributed, decentralized organizational structures.
Consequently, many organizations will increasingly design and implement group/organizational/global DSS. Global management support systems (MSS) will emerge as a key element in management decision making and as an essential weapon against global competitors.

Supporting global business activities is becoming a most important and extremely complex task. To effectively cope with multinational managerial problems such as multiple currency management, foreign exchange risk management, global tax management and global consolidated reporting, global DSS are not enough. It is essential to develop an integrated global MSS which integrates EIS, artificial neural networks, ES with knowledge base captured from numerous experts in the same subject area as well as from a variety of specialists in international financial management, international accounting, international tax areas, and so forth…

Web-Based Decision Support Systems

Is a computerized system that delivers decision support information or decision support tools to a manager or business analyst using a (thin-Client) Browser like Microsoft internet Explorer, Mozilla Firefox, Google Chrome …etc.

The computer server that is hosting the DSS application is linked to the user's computer by a network with the TCP/IP protocol.
Using web-based DSS provide services that could be accessible to anyone with a problem and internet connection.
At a higher level of organization, the concept of web DSS involves the creation of an electronic market of decision technologies, where the market would bring together, and provide services for matching consumers, providers, and web-enabled decision computation services.

A number of topologies have been proposed for organizing our knowledge about DDS And the two most widely implemented approaches are Data-Driven and Model-Driven DSS.
Data-Driven DSS help managers to organize, retrieve, and synthesize large volume of relevant data using data base queries.
OLAP (On-Line Analytical Processing) techniques, and data mining tools which are Model-Driven DSS, use formal representation of decision models and provide analytical support using the tool of decision analysis, Optimization, Stochastic modeling, simulation, statistics, and logic modeling.
Three other approaches have become more wide spread due to the sophisticated web and communication technologies:

1- Communication-Driven DSS, rely on electronic communication technologies to link multiple decision makers who might be separated by place and time, or to link decision makers with relevant information and tools.
2- Knowledge-Driven DSS, can suggest or recommend actions to managers.
3- Document-Driven DSS, integrate a variety of storage and processing technologies to provide managers document retrieval and analysis.

Web Technologies and DSS tasks

To understand how web tech can influence the development, deployment, and use of DSS, Fig. 2 summarizes the relationships among 10 major tasks involved in building and using Data-Driven and Model-Drive DSS. For example, using an application-specific Model-Driven DSS, the user will be given the relevant decision models and data, focusing on tasks, such as model execution, development of reports, or analysis.

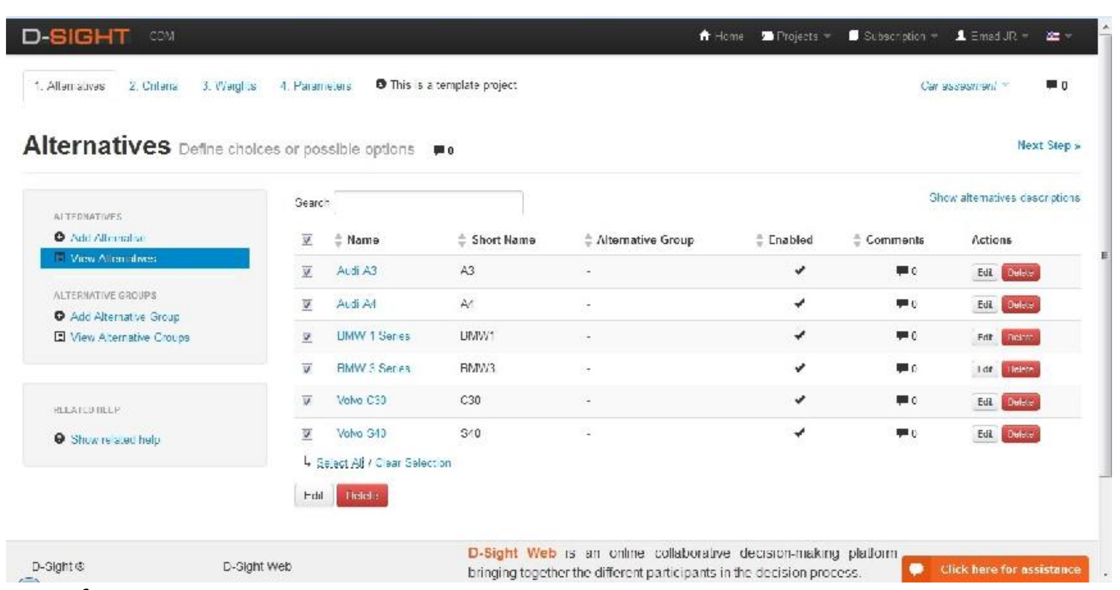
Using a corresponding DSS generator, on the other hand, would require the performance of additional tasks such as model definition and creation of a custom user interface. Model-Driven DSS often involve all the tasks on the model rows as well as those for an Application- specific DSS. The 10 distinct DSS related tasks that can be executed by users from a Web Browser include:
Model definition, data definition, analysis definition, and user interface definition.

Model-driven	Model instantiation Model execution Analysis and reports	→	Model definition Analysis definition U.I. definition
↑	↑		↑
Data-driven	Data visualization Query and Retrieval Data analysis	→	Data definition Analysis definition U.I. definition
	Application-specific	→	DSS Generator

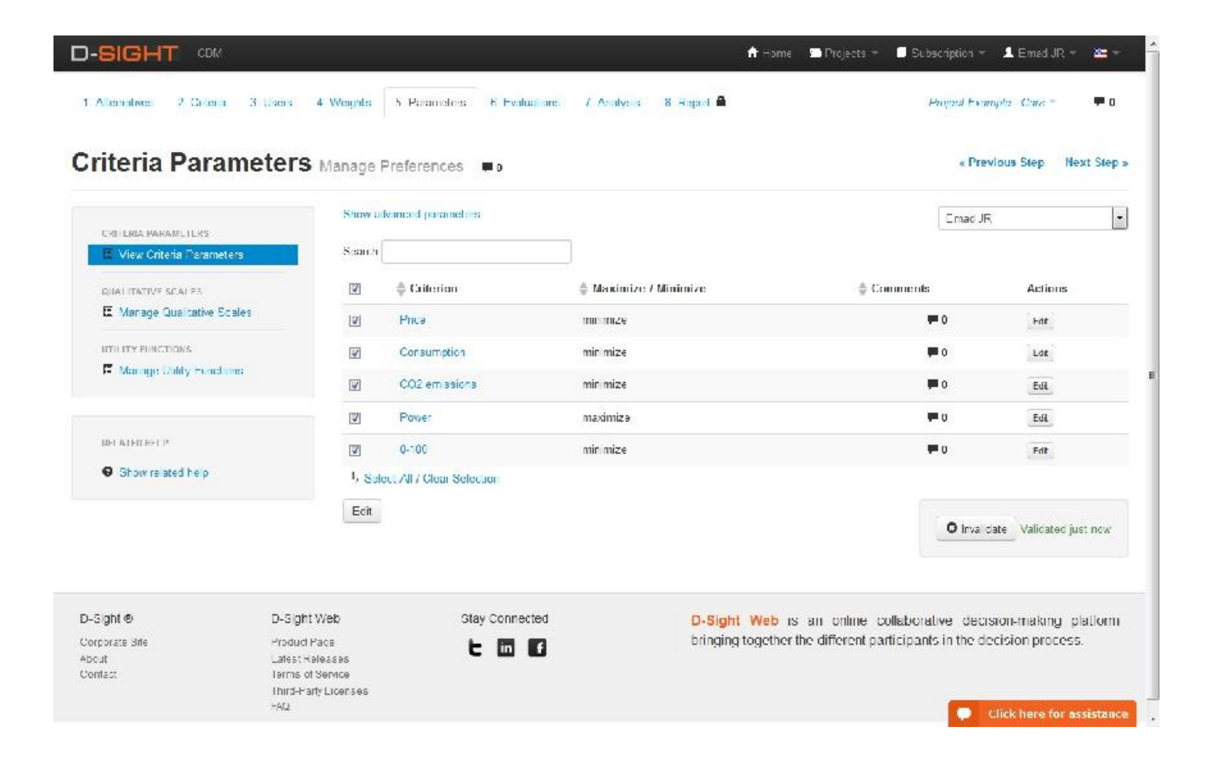
Figure 2 . Working with Decision Support Systems: Common Tasks

An Example of web-based DSS website services:

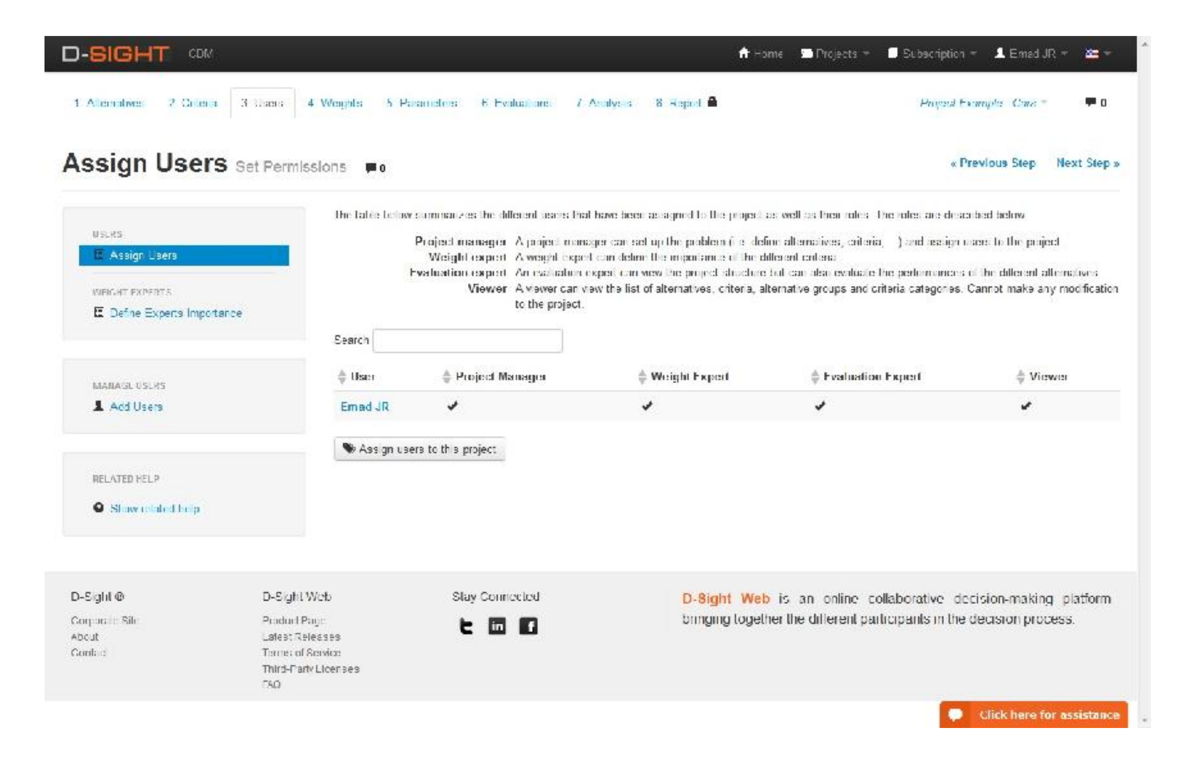
The following web-base DDS represent **steps** of an example of such application:
https://web.d-sight.com/cdm/en/projects
1- Define Alternatives (Choices or options):



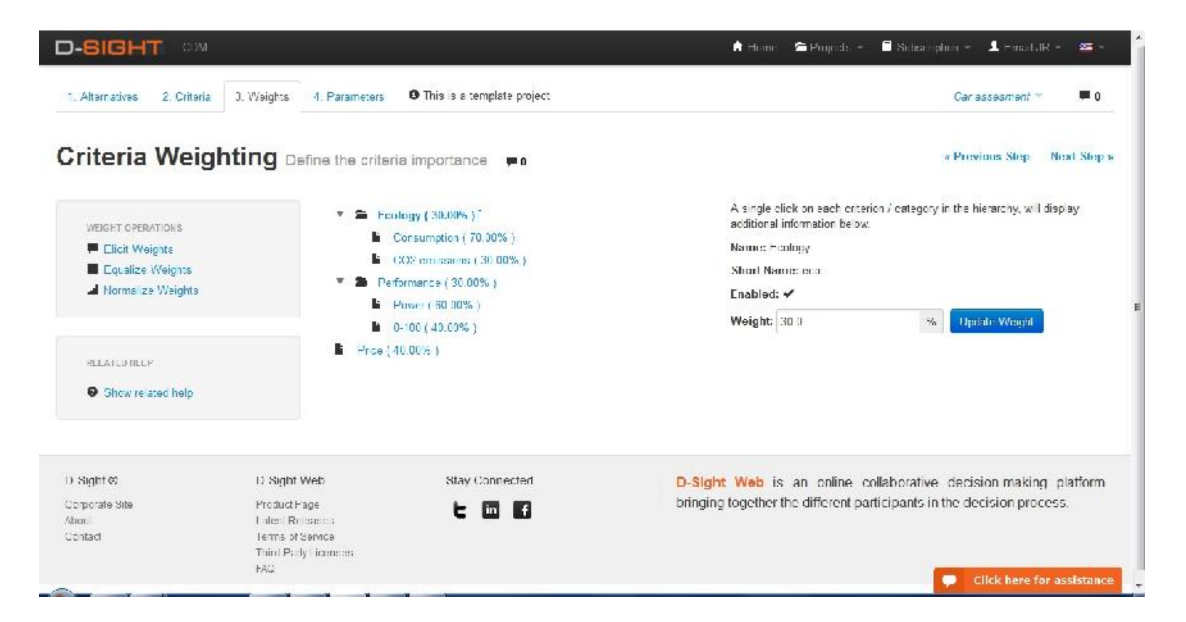
2- Define Criteria Parameters:



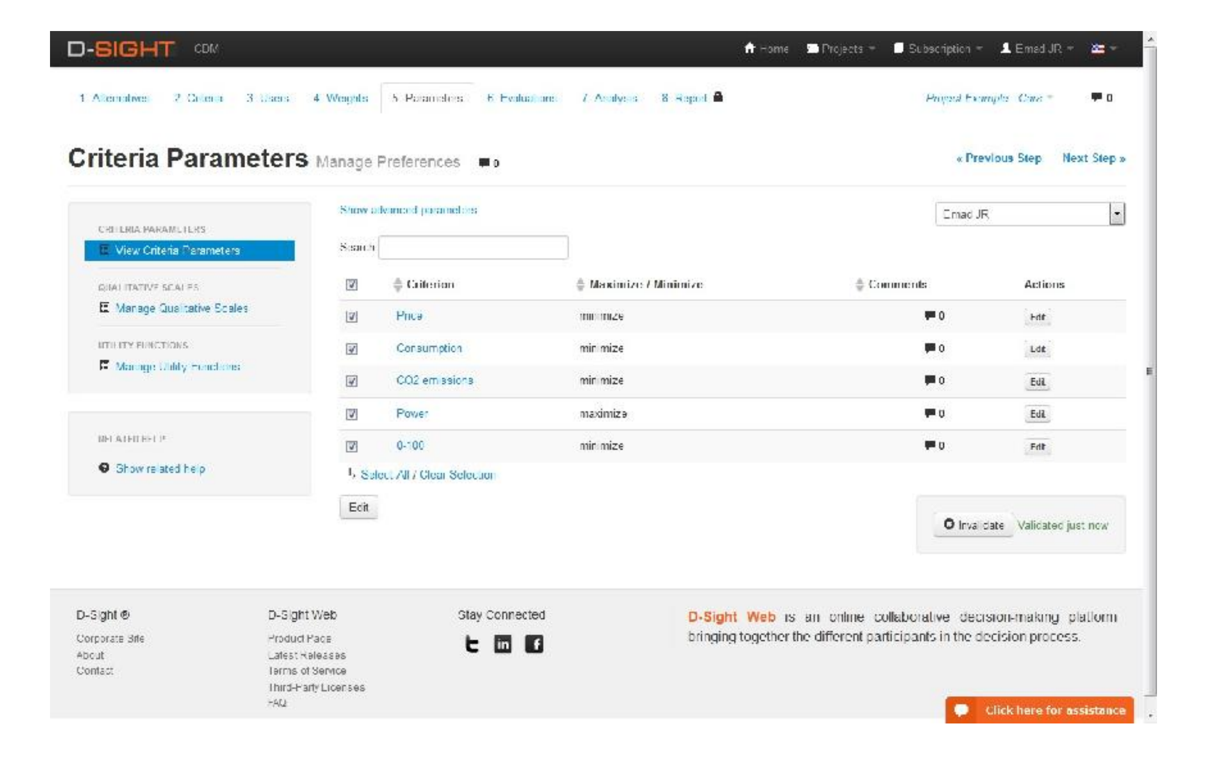
3- Define Users:



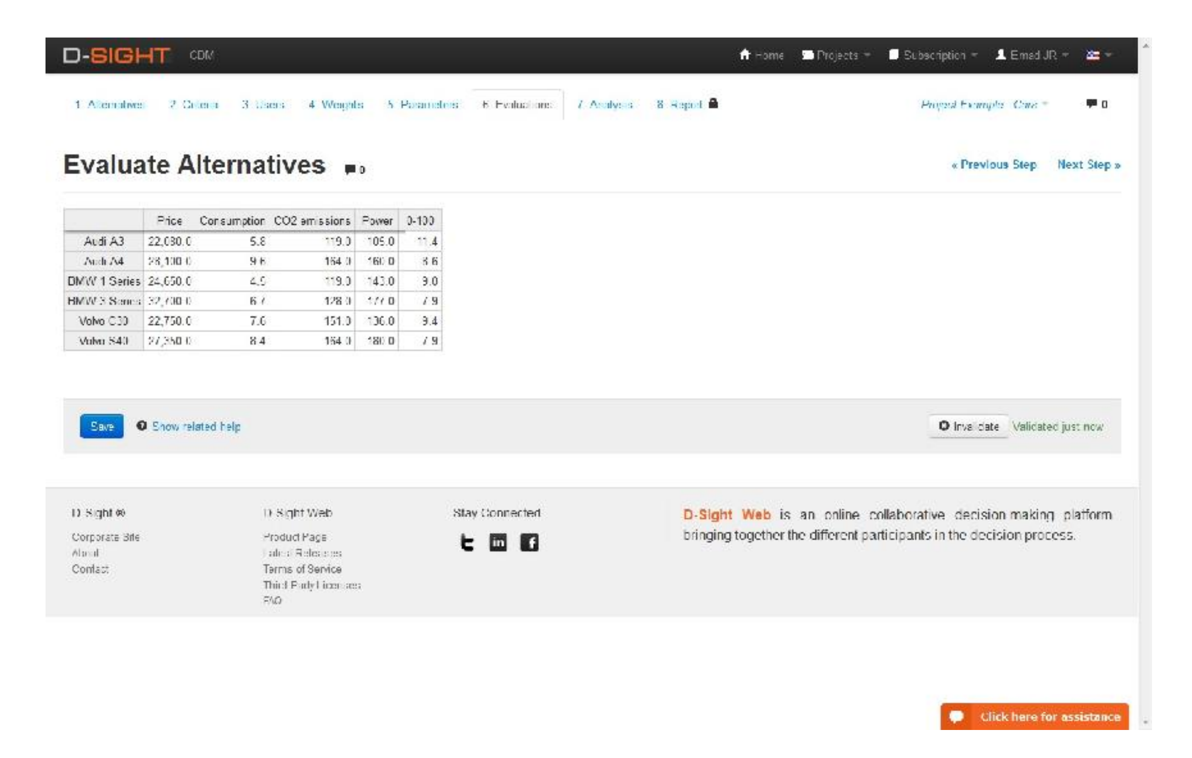
4- Defining Criteria weighting (according to user's importance):



5- Set Criteria Parameters:

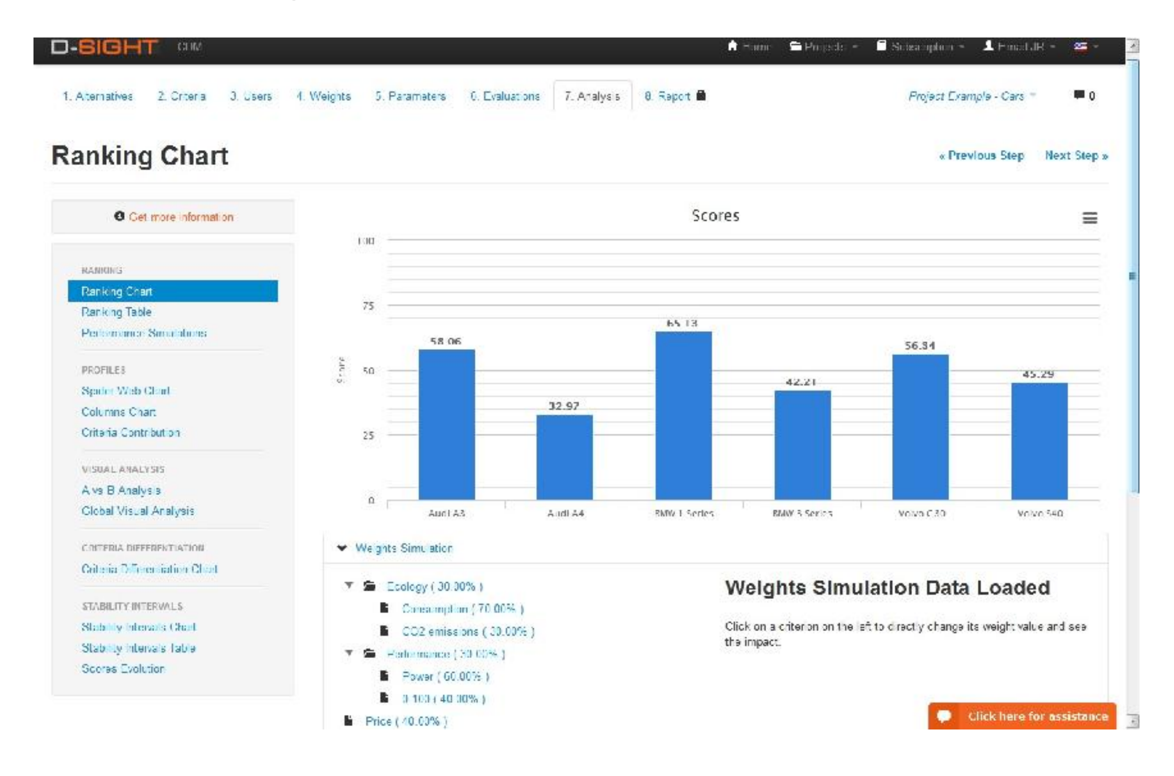


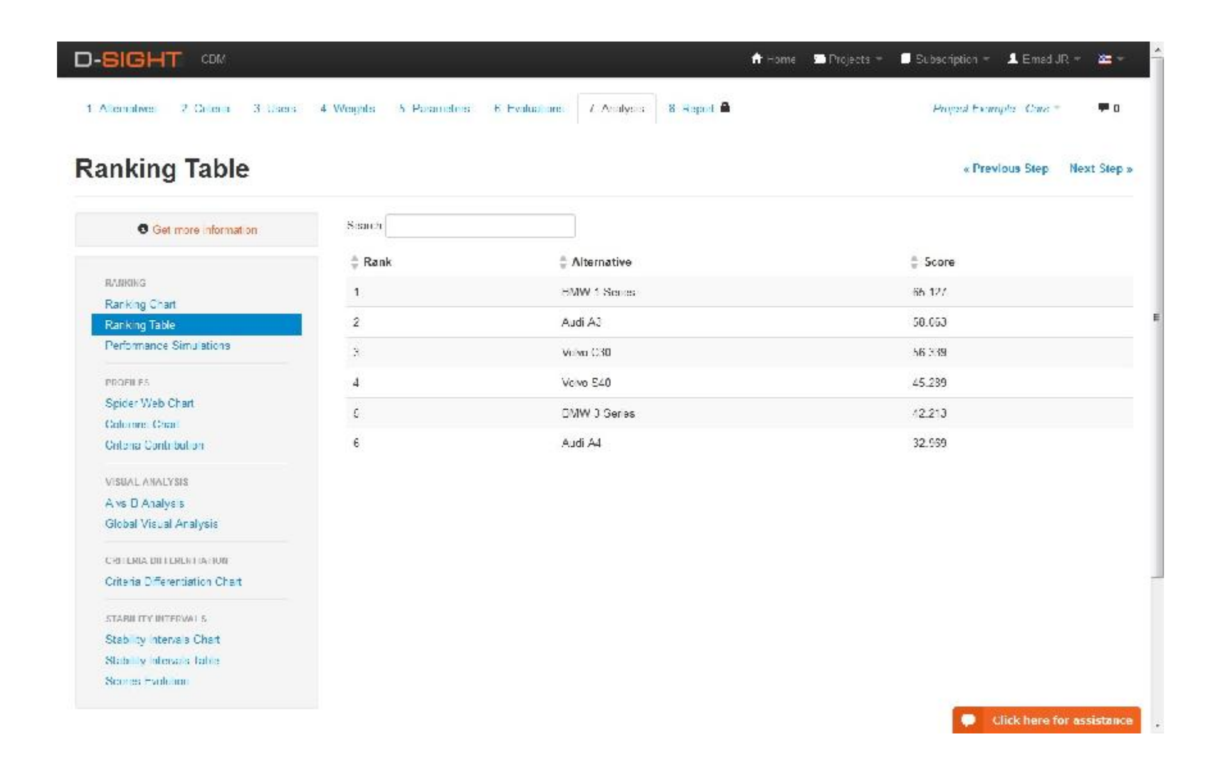
6- Set Evaluation Alternatives:

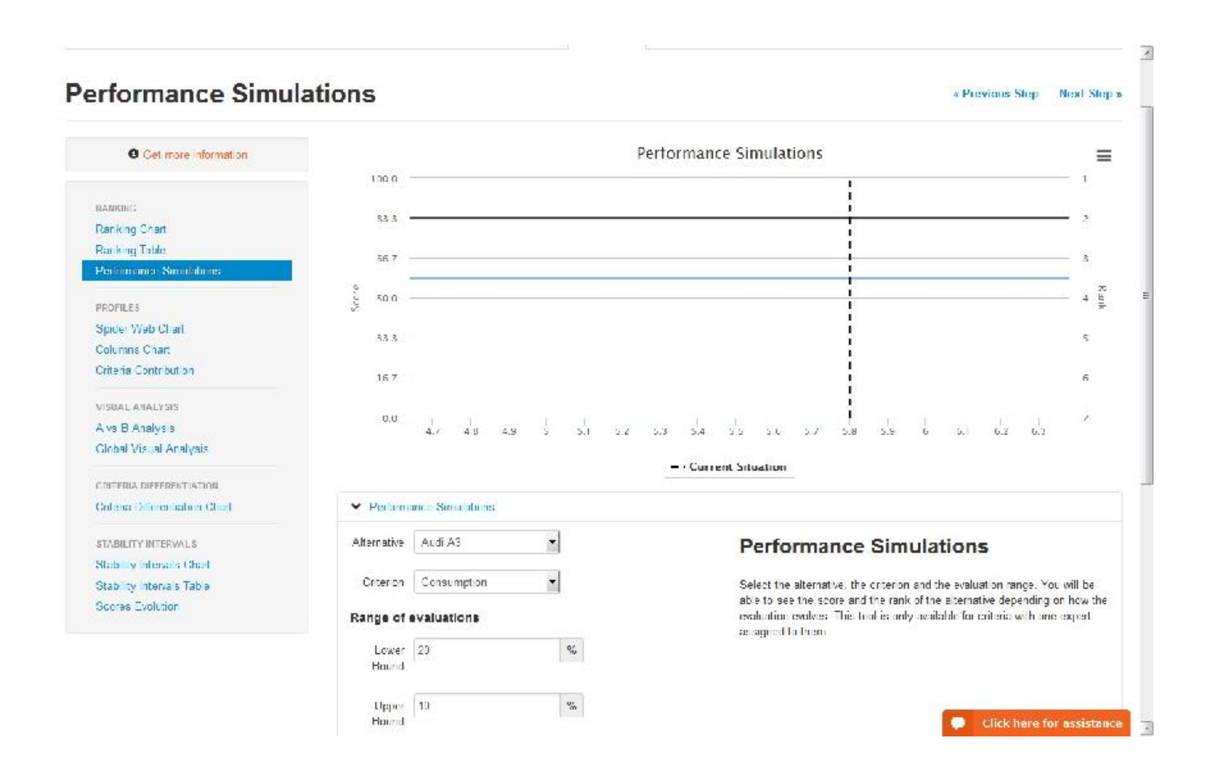


7- Analyze phase:

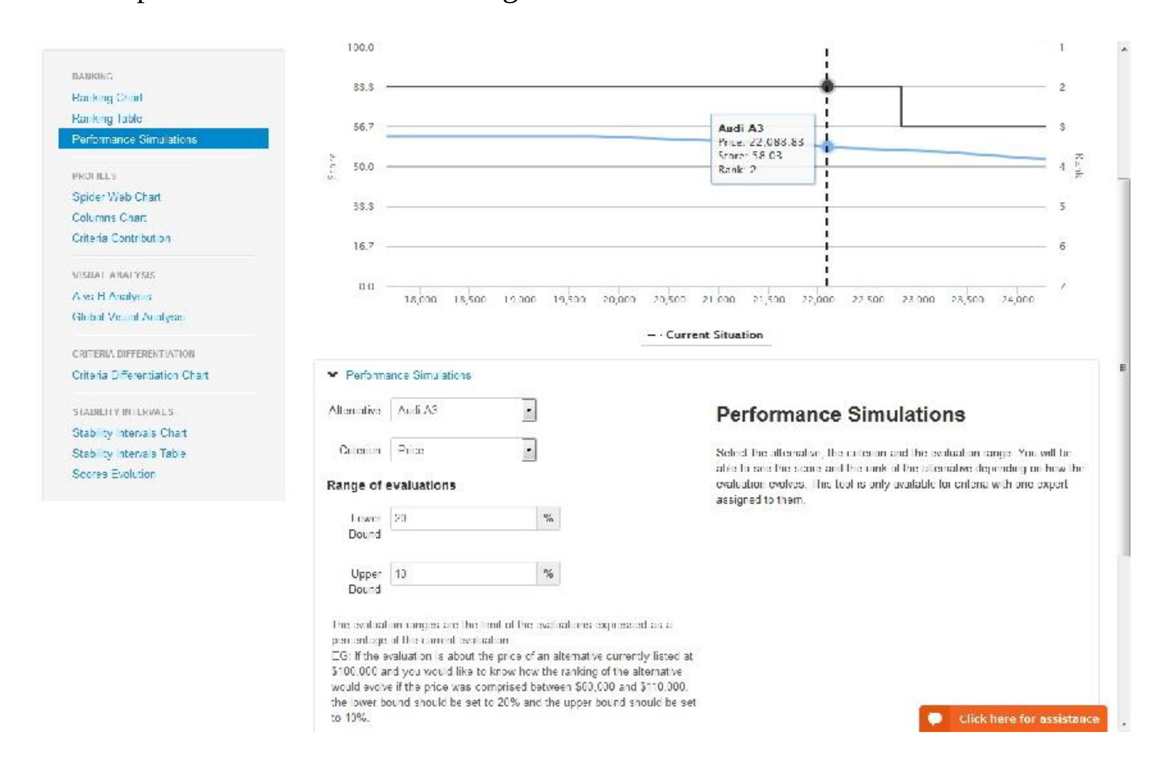
At this stage, user can analyze the data using different types of Charts and tables, as seen in the following:

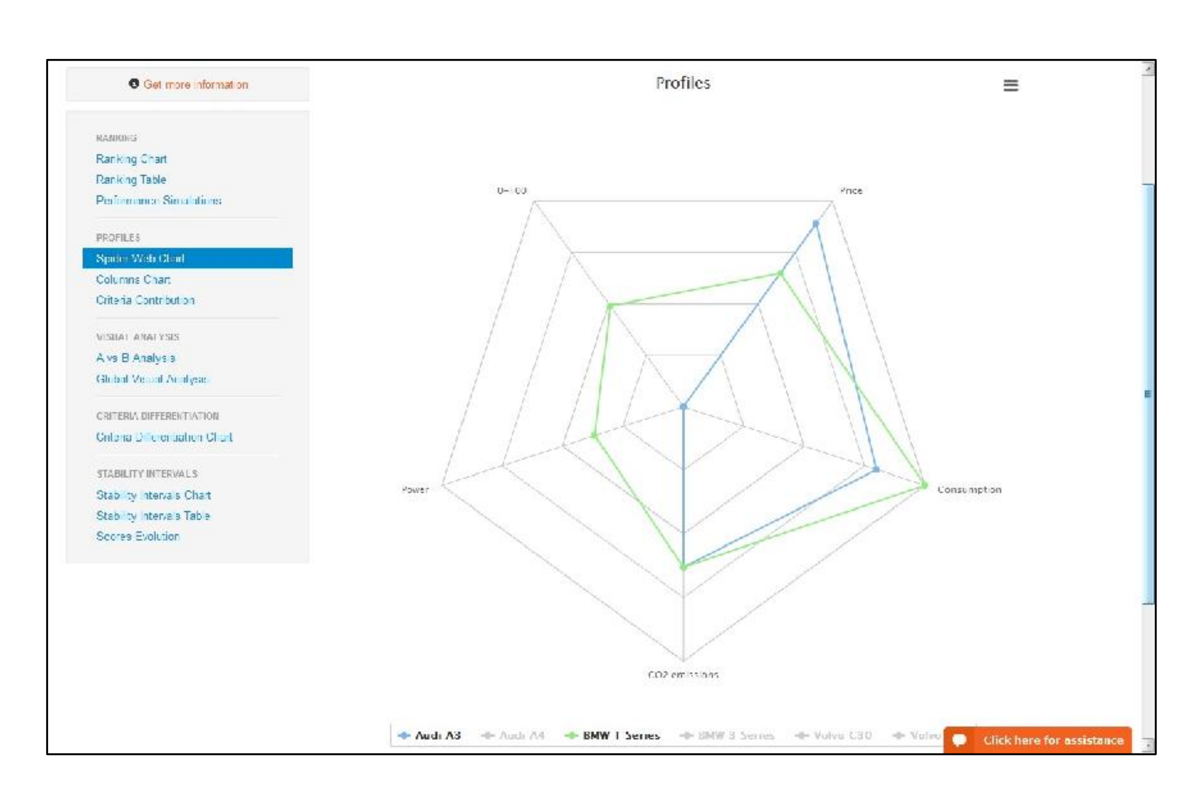


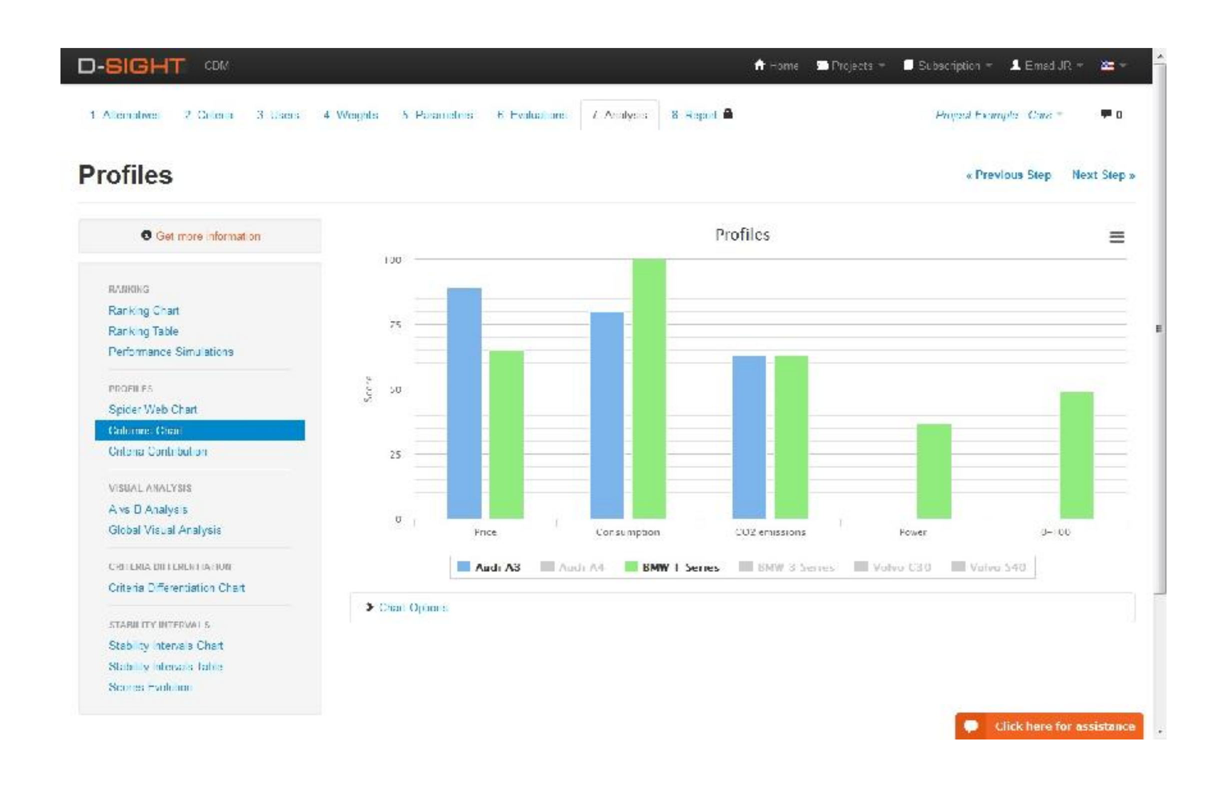

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Volvo S40
45.239
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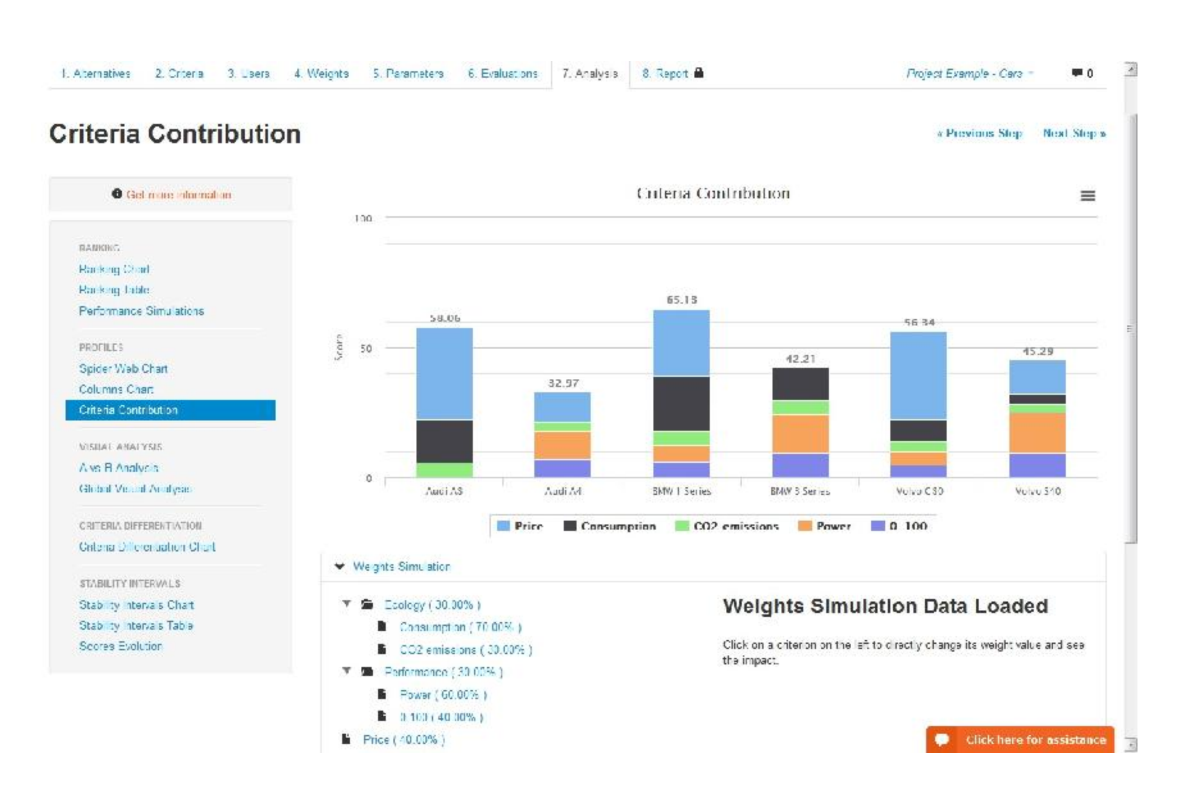

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Current Situation
Alternative
Audi A3
Consumption
Range of evaluations
Performance Simulations
Select the alternative, the criterion and the evaluation range. You will be able to see the score and the rank of the alternative depending on how the evaluation evolves.
Click here for assistance

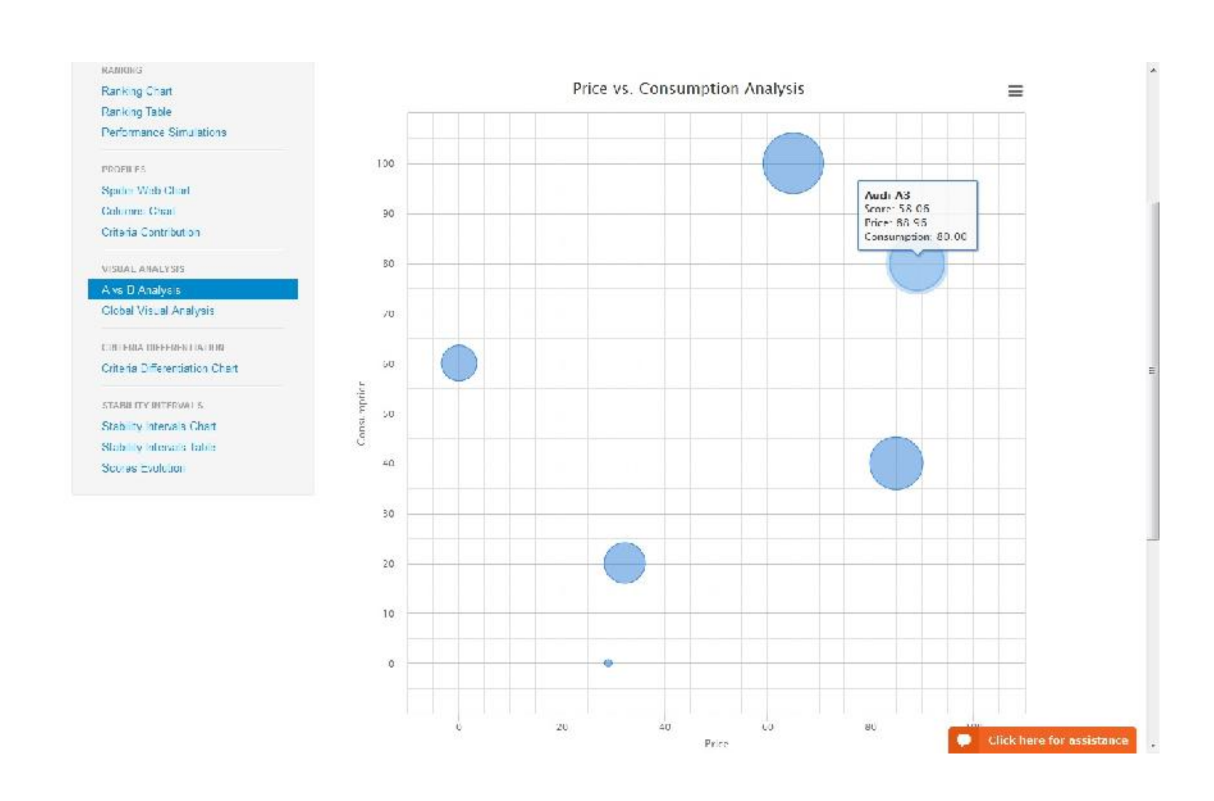
Another performance simulation using different criteria:

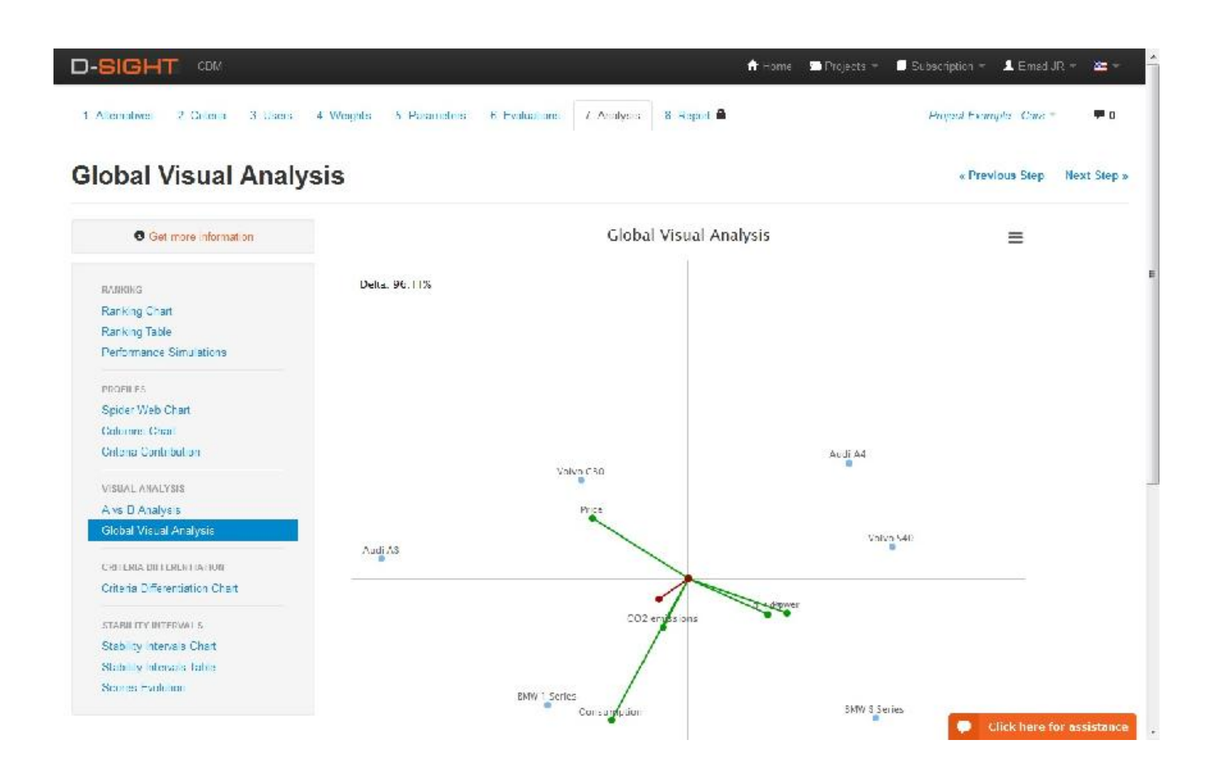


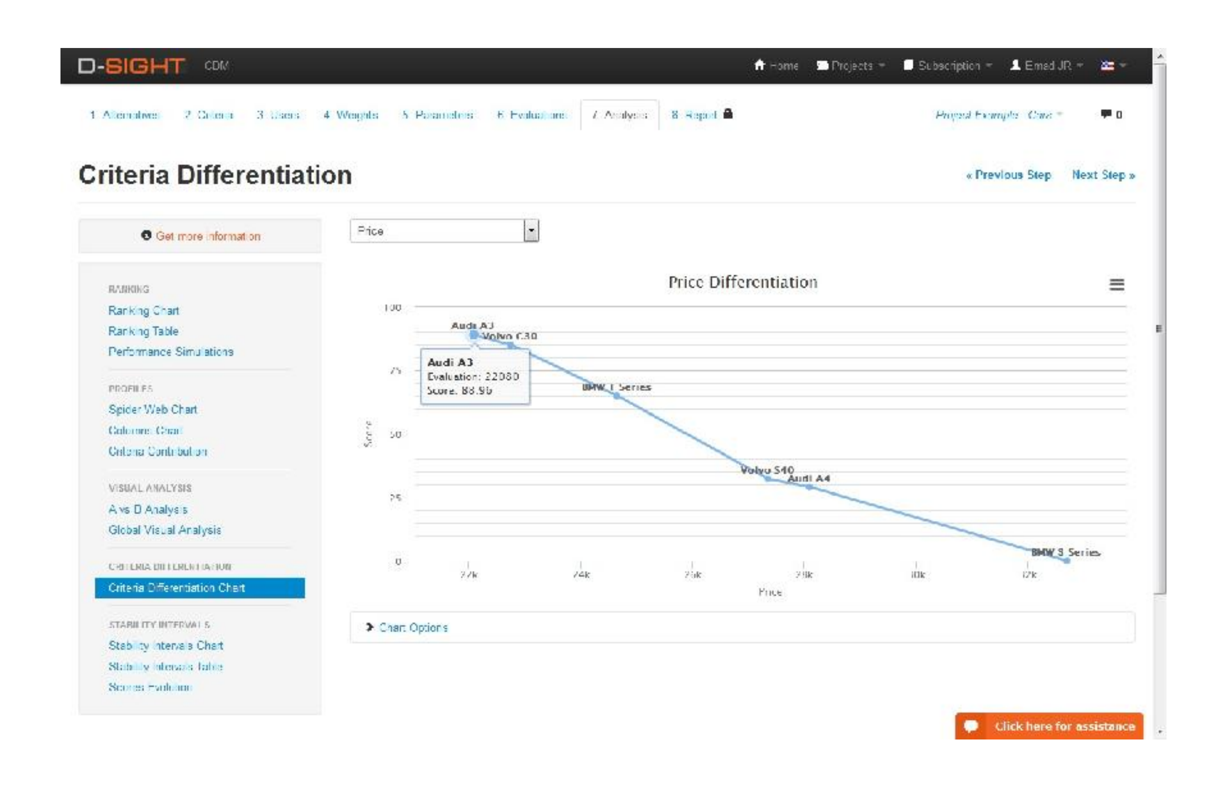


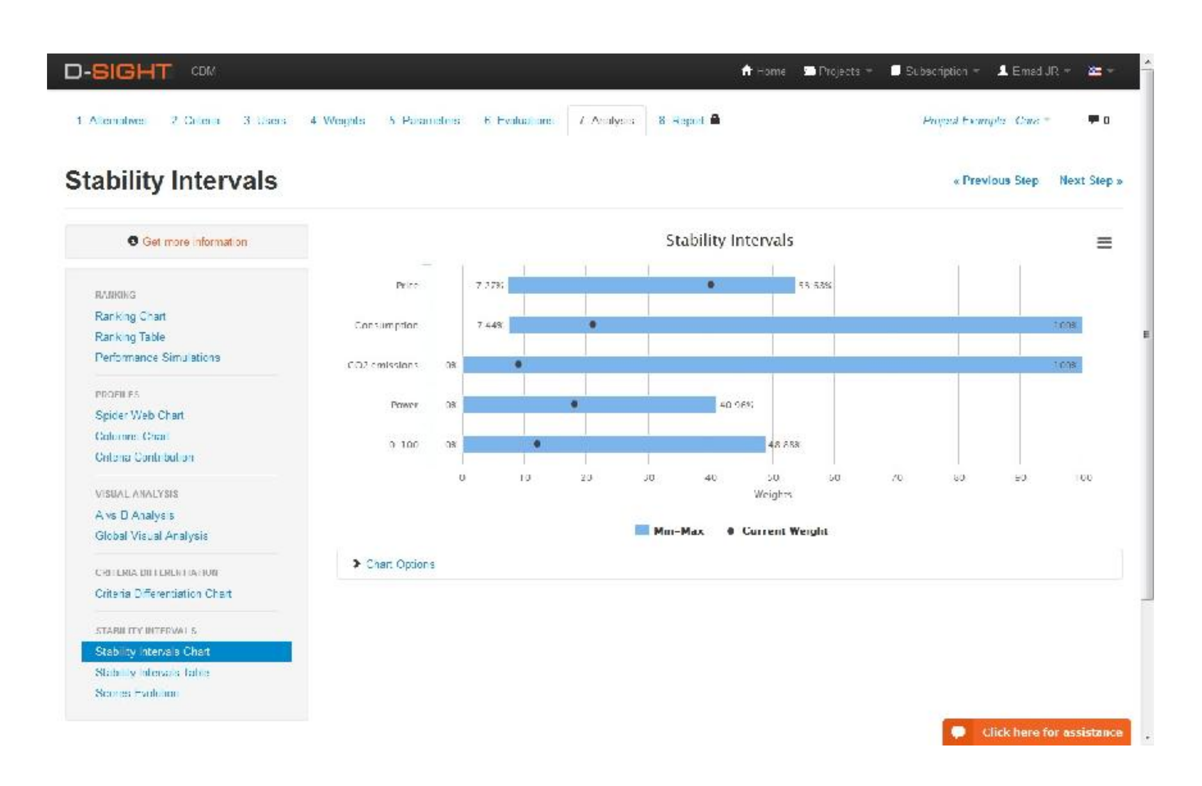

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Volvo S40
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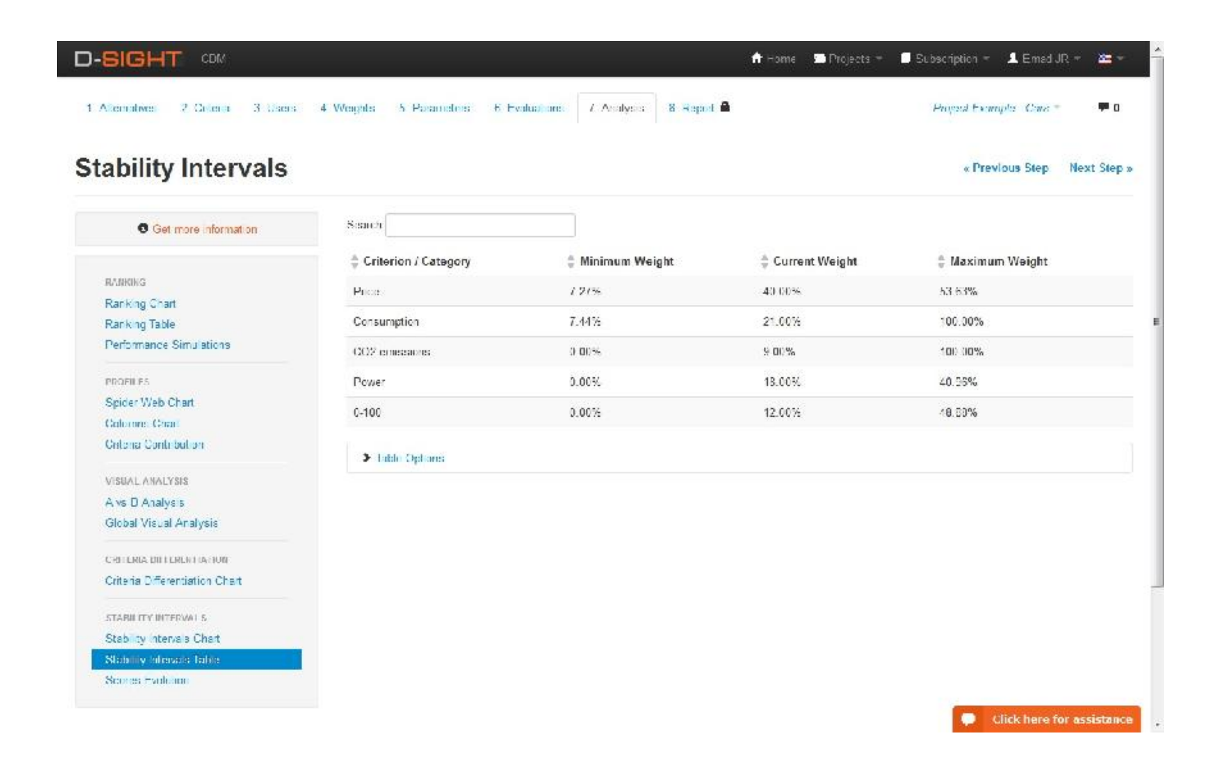

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Consumption (70.00%)
CO2 emissions (30.00%)
Performance (30.00%)
Power (60.00%)
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Price (40.00%)
Weights Simulation Data Loaded
Click on a criterion on the left to directly change its weight value and see the impact.
Click here for assistance

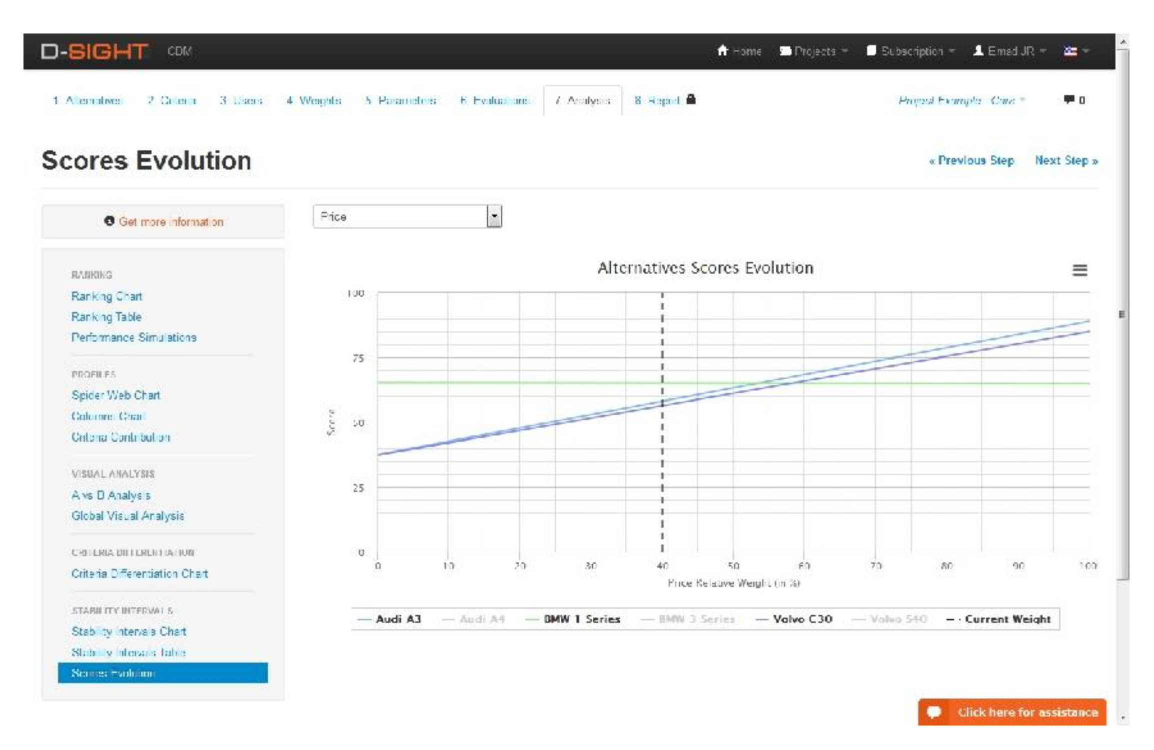

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Audi A3
Consumption: 80.00
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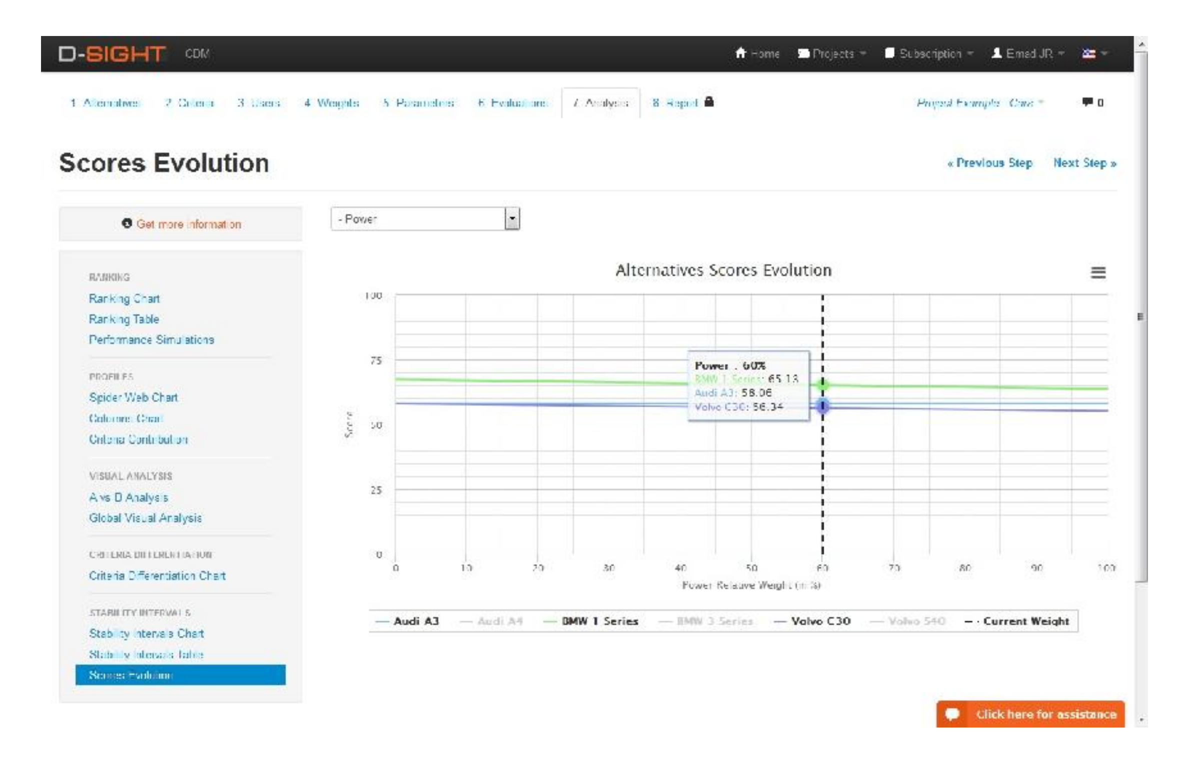

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8- Reports:

This is the important final phase of DSS output, it provides different reports generated according to analysis phase.
Since these reports will be critical to the user, then only the paid application user will get these reports while unpaid subscriber will find it locked!

Lecture edited and compiled by
Assist. Professor Emad Jihad
Master study course in IT
2014-2015